REMARKS

Claims 1–52 and 76–81 will be pending. Claims 1, 2, 16, 26, 27, 30, and 31 have been amended to clarify the scope of these claims. Claims 2, 16, 26, and 31 have been rewritten in independent form, including only those limitations present in these claims as originally filed. Support for the claim amendments may be found in the specification, for example, page 9, line 30 – page 10, line 5, as well as in the originally filed claims. No new matter has been added.

Applicants note with appreciation that the Examiner has indicated that claim 35 is allowable.

Rejection of Claims under 35 U.S.C. § 103

Claims 1, 4–9, 23–25, 37, 38, and 76–79 are rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,960,728 to Schaake et al. ("Schaake") in view of U.S. Patent Publication No. 2004/0060518 by Nakamura et al. ("Nakamura"). Schaake appears to disclose the formation of II-VI films by MBE or MOCVD, and the performance of a homogenization anneal. *See* column 1, lines 63–65. Schaake does not teach or suggest rotating the substrate during the formation of the semiconductor layer; the Examiner relies on Nakamura for the disclosure of this feature.

Neither of the cited references teaches or suggests a semiconductor layer in which the initial compositional variation is caused by the rotation of a substrate during the formation of the semiconductor layer, and is reduced by annealing. Rather, the compositional variation in the II-VI films formed by Schaake appears to be caused by surface faceting during the growth of the films, leading to local variations in the alloy ratio. *See* column 2, lines 15–18. Moreover, one of skill in the art would find no motivation in the cited references to cause an initial compositional variation by rotation of the substrate and annealing the film to reduce the variation. The starting material of Schaake already has a compositional variation that is homogenized by an anneal, and there is no motivation in the references to increase the compositional variation further by rotating the substrate in the manner described by Nakamura.

Applicants submit that for at least this reason, amended independent claim 1 and claims dependent therefrom are patentable over the cited prior art.

Claims 1–3, 19–22, and 42 are rejected re rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,841,457 to Bedell et al. ("Bedell") in view of Nakamura. Bedell discloses the formation of a Si_xGe_{1-x} layer over a single crystal Si layer. *See* column 6, lines 35–46. A subsequent anneal is performed to relax the strained SiGe alloy and to permit interdiffusion of Ge throughout the first single crystal Si layer and SiGe alloy layer. The anneal apparently causes Ge atoms to merely be redistributed within the Si_xGe_{1-x} layer and Si layer. *See* column 8, lines 11–21. As the Examiner recognizes, Bedell does not teach or suggest rotating the substrate during the formation of the semiconductor layer; the Examiner relies on Nakamura to provide this feature.

Bedell appears to disclose the redistribution of Ge in <u>two</u> layers; Bedell does not teach or suggest reducing an initial compositional variation <u>within a</u> layer, as recited in independent claims 1 and 2.

The Examiner states that the redistribution of Ge in two layers, as disclosed by Bedell, will result in the reduction of the initial compositional variation in the SiGe layer because of the redistribution of some of the Ge atoms into the Si layer. Applicants respectfully disagree. Lowering the <u>concentration</u> of the Ge in the original Si_xGe_{1-x} layer of Bedell does not necessarily reduce the initial compositional <u>variation</u>, as recited in independent claims 1 and 2. In fact, the diffusion of Ge is likely to <u>increase</u> the initial compositional variation in the original Si_xGe_{1-x} layer such that the Ge concentration is lowest at the Si_xGe_{1-x}/Si interface, i.e., at the point where Ge atoms diffuse from the Si_xGe_{1-x} layer into the Si layer and Si atoms diffuse from the Si layer into the Si_xGe_{1-x} layer, and highest at a distal portion of the Si_xGe_{1-x} layer.

Moreover, one of skill in the art would find no motivation in the cited references to rotate the substrate of Bedell as disclosed by Nakamura. Bedell discloses several epitaxial growing processes suitable for use with his invention, but does not mention MOCVD as taught by Nakamura. *See* column 6, lines 49–62. The deposition methods contemplated by Bedell are not described as inducing the non-uniform gas distribution typical of MOVPE, as described by Nakamura. *See* paragraph [0006]. More specifically, during MOVPE, a large and non-uniform boundary layer thickness of hot air may form over the wafers as a result air flow patterns and the

heating of the susceptor. *See* paragraph [0006] Nakamura notes that these boundary layer conditions lead to non-uniform deposition and discloses rotation of wafers as a method for improving this non-uniformity. *See* paragraph [0009]. Bedell, on the other hand, does not disclose gas distribution non-uniformities. Moreover, Bedell is also silent about any layer thickness non-uniformity. One of skill in the art, therefore, would find no motivation to rotate the wafer of Bedell as taught by Nakamura.

Applicants submit that for at least these reasons, amended independent claims 1 and 2, and claims dependent therefrom, are patentable over the cited prior art.

Claims 1 and 10–15 are rejected under 35 U.S.C. § 103(a) as anticipated by U.S. Patent No. 4,914,488 to Yamane et al. ("Yamane") in view of Nakamura.

Yamane describes a superlattice film having two kinds of layers with different compositions. *See* abstract. By subjecting the superlattice film to an annealing step, "the composition distribution can be smoothened. The superlattice structure can be transformed to a continuous structure of a graded composition." *See* column 7, lines 15–28. As the Examiner recognizes, Yamane does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Nakamura to provide this feature.

The compositional variation in Yamane's superlattice appears to be formed by the deposition of superthin layers. *See* column 6, lines 56–63. One of skill in the art would find no motivation in the cited references to cause an initial compositional variation by rotation of the substrate and annealing the film to reduce the variation, as recited in amended independent claim 1. The starting material of Yamane already has a compositional variation, i.e., precisely alternating layers of different materials. There is no motivation in the references to increase this initial variation further by rotating the substrate as described by Nakamura.

Applicants submit that for at least this reason, amended independent claim 1 and claims dependent therefrom are patentable over the cited prior art.

Claims 1, 16–18, and 41 are rejected under 35 U.S.C. § 103 as unpatentable over U.S. Patent No. 6,515,335 to Christiansen et al. ("Christiansen") in view of Nakamura. Christiansen appears to disclose the formation of Ge or SiGe islands on top of a Si layer by, e.g., MBE or CVD. A subsequent anneal causes intermixing between the islands and the Si layer. *See*, e.g.,

column 5, lines 18–30, column 6, lines 5–15 and 42–46. As the Examiner recognizes, Christiansen does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Nakamura to provide this feature.

Christiansen appears to disclose the redistribution of Ge in two layers; Christiansen does not teach or suggest reducing an initial compositional variation within a layer, as recited in independent claims 1 and 16. Furthermore, lowering the concentration of the Ge in the original SiGe islands disclosed by Christiansen does not necessarily reduce the initial compositional variation, as recited in claims 1 and 16. On the contrary, the diffusion of Ge is likely to increase the initial compositional variation in the original SiGe islands such that the Ge concentration is lowest at the SiGe/Si interface, i.e., at the point where Ge atoms diffuse from the SiGe islands into the Si layer and Si atoms diffuse from the Si layer into the SiGe islands, and highest at a distal portion of the SiGe islands.

Applicants submit that for at least these reasons, amended independent claims 1 and 16, and claims dependent therefrom, are patentable over the cited prior art.

Claims 1, 22, 23, 31, 32, 34, and 42–44 are rejected under 35 U.S.C. § 103 as unpatentable over U.S. Patent Publication No. 2002/0146892 by Notsu et al. ("Notsu") in view of Nakamura. Notsu appears to disclose forming a Si layer over a SiGe layer by CVD, diffusing Ge into the Si layer to form a SiGe layer, and annealing the layers such that the Ge concentration in the second SiGe layer becomes uniform. *See*, e.g., paragraphs [0101], [0102], and [0113]. As the Examiner recognizes, Notsu does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Nakamura to provide this feature.

Notsu appears to disclose the redistribution of Ge in several layers, rather than within a layer, as recited in independent claims 1 and 31. Furthermore, lowering the concentration of the Ge in the original SiGe layer disclosed by Notsu does not necessarily reduce the initial compositional variation, as recited in claims 1 and 31. On the contrary, the diffusion of Ge is likely to increase the initial compositional variation in the original SiGe layer such that the Ge concentration is lowest at the SiGe/Si interface, i.e., at the point where Ge atoms diffuse from the original SiGe layer into the Si layer and Si atoms diffuse from the Si layer into the SiGe layer, and highest at a distal portion of the SiGe layer.

Applicants submit that for at least these reasons, amended independent claims 1 and 31, and claims dependent therefrom, are patentable over the cited prior art.

Claims 1, 22, and 26–30 are rejected under 35 U.S.C. § 102 as being anticipated by U.S. Patent Publication No. 2004/006744 by Malik et al. ("Malik"). Malik discloses forming a strained SiGe layer by MBE or CVD, and then relaxing it by an annealing step. *See* paragraphs [0013]– [0016]. Malik discusses only changing the stress level of the SiGe layer, and is silent about changing the composition of the SiGe layer. As the Examiner recognizes, Malik does not teach or suggest rotating the substrate during the formation of the semiconductor layer. The Examiner relies on Nakamura to provide this feature. As the Examiner also recognizes, Malik does not teach or suggest annealing a semiconductor layer to reduce the initial compositional variation within a layer, as recited in independent claims 1 and 26. The Examiner relies on US Patent Publication No. 2002/168802 to Hsu ("Hsu") to provide this feature. Hsu discloses annealing a layer structure to diffuse Ge into a Si layer to form a relaxed SiGe layer. *See* paragraph [0008]. The Examiner asserts that the relaxation anneal will reduce the initial compositional variation at least with respect to Ge in some portions of the structure. Applicants respectfully disagree. Hsu, also, is silent about reducing initial compositional variations; Hsu merely employs an anneal to form a relaxed SiGe film.

The Examiner states that because Hsu discloses diffusing Ge to convert a silicon film into relaxed $Si_{1-x}Ge_x$, some of the Ge atoms within the initial SiGe layer diffuse into the top silicon film; accordingly, the initial compositional variation in the initial SiGe layer is reduced. The Examiner also reasons that, because Malik anneals a SiGe layer formed directly on a Si wafer, Hsu should be read as teaching that some of the Ge atoms within Malik's SiGe layer would diffuse into the Si wafer.

Applicants disagree. Lowering the concentration of the Ge in the original SiGe layer disclosed by Malik does not necessarily reduce the initial compositional variation, as recited in claims 1 and 26. Rather, the outdiffusion of Ge into neighboring Si is likely to increase the initial compositional variation in the original SiGe layer such that the Ge concentration is lowest at the SiGe/Si interface, i.e., at the point where Ge atoms diffuse from the SiGe layer into the Si layer and Si atoms diffuse from the Si layer into the original SiGe layer, and highest at a distal portion of the SiGe layer.

Applicants submit that for at least these reasons, amended independent claims 1 and 26, and claims dependent therefrom, are patentable over the cited prior art.

Claims 45–49 and 52 are rejected under 35 U.S.C. § 103 as being obvious over U.S. Patent No. 5,844,260 to Ohori ("Ohori") in view of U.S. Patent No. 5,218,417 to Gay ("Gay"). Ohori discloses forming an InGaAs layer exhibiting undulation in an upper surface because of cross hatching, and removing the cross hatching by polishing, thereby providing a mirror finish. *See* column 11, lines 4–14. The Examiner recognizes that Ohori is silent with respect to the roughness wavelength of the haze. The Examiner asserts that haze is conventionally defined as the ratio of the diffused/scattered component of transmitted light to the total amount of light transmitted by a thin film for the wavelengths of light to which a photodetector is sensitive, citing Gay for the first time as support for this proposition. *See* column 1, lines 15–19.

Applicants note, however, rather than using the term haze as conventionally defined, Gay expressly uses this term to mean "the macroscopically observable ability of a thin film to scatter, reflect, or transmit light in reference to an <u>arbitrary</u> relative haze scale." *See* column 1, lines 19–22 (emphasis added).

The Examiner states that Gay discloses making haze measurements utilizing wavelengths of 500 and/or 800 nm, and, therefore, the haze measured by Gay would also have a roughness wavelength of less than 1 micrometer. Claim 45 recites haze having a fine-scale roughness wavelength of < 1 micrometer; the Examiner appears to equate this fine-scale roughness wavelength with the instrumentation wavelength at which measurements are made. To support the combination of these references, the Examiner states:

> It would have been obvious ... to determine the haze in Ohori's semiconductor layer by utilizing any means known in the art; accordingly, it would have been obvious to one of ordinary skill in the art to incorporate Gay's measuring system to determine haze at a fine-scale roughness wavelength of less than 1 micrometer.

Applicants disagree. The mere possibility that one might decide to use Gay's measuring system to measure Ohori's haze does not prove that Ohori's haze has the fine-scale roughness recited in claim 45. Furthermore, Gay is silent about the absolute value of the features measured by the disclosed measuring system. This measuring system uses a wavelength of less than 1 micrometer; this wavelength, however, may be used to measure features having dimensions greater than 1 micrometer. Analogously, a decision to weigh an item by using a spring scale

having a sensitivity of ± 1 pound does not mean the scale is capable of measuring only items that weigh approximately 1 pound or less.

Accordingly, neither Ohori nor Gay, alone or in combination, teaches or suggests haze comprising a fine-scale roughness wavelength of less than 1 micrometer, as recited in independent claim 45.

Applicants submit that for at least this reason, independent claim 45 and claims dependent therefrom are patentable over the cited prior art.

Claims 45 and 49–51 are rejected under 35 U.S.C. § 103 as being unpatentable over U.S. Patent No. 6,107,653 to Fitzgerald ("Fitzgerald") in view of Gay. Fitzgerald teaches forming a semiconductor layer, e.g., a SiGe layer, and planarizing a surface of the layer to remove surface roughness caused by dislocations introduced during relaxation. *See*, e.g., column 3, lines 31–39. The Examiner asserts that this surface roughness results in the formation of a haze.

The Examiner recognizes that Fitzgerald is silent regarding the degree of surface roughness and relies on Gay to provide this feature. The Examiner asserts that haze is conventionally defined as the ratio of the diffused/scattered component of transmitted light to the total amount of light transmitted by a thin film for the wavelengths of light to which a photodetector is sensitive, citing Gay for the first time as support for this proposition. *See* column 1, lines 15–19.

Similarly, as discussed above with respect to Ohori, the mere possibility that one might decide to use Gay's measuring system to measure Fitzgerald's surface roughness does not prove that the semiconductor layer of Fitzgerald has the fine-scale roughness recited in claim 45.

Neither Fitzgerald nor Gay, alone or in combination, teaches or suggests haze comprising a fine-scale roughness wavelength of less than 1 micrometer, as recited in amended independent claim 45.

Applicants submit that for at least this reason, independent claim 45 and claims dependent therefrom are patentable over the cited prior art.

CONCLUSION

In light of the foregoing, Applicants respectfully submit that all claims are now in condition for allowance.

A check for $1390.00 is enclosed for the filing of a Request for Continued Examination and for the extra claim fee. Applicants believe that no additional fees are necessitated by the present Response. However, in the event that any additional fees are due, the Commissioner is hereby authorized to charge any such fees to Deposit Account No. 07-1700.

If the Examiner believes that a telephone conversation with Applicants' attorney would expedite allowance of this application, the Examiner is cordially invited to call the undersigned attorney at (617) 570-1806.

Respectfully submitted,

Date: August 3, 2006
Reg. No. 44,381

Natasha C. Us
Attorney for Applicants
Goodwin Procter LLP
Exchange Place
Boston, Massachusetts 02109

Tel. No.: (617) 570-1806
Fax No.: (617) 523-1231

LIBC/2814204.1